
Personal Health Mashups: Mining significant observations from wellbeing data and context

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Abstract

There has recently been large growth in relatively inexpensive consumer devices that capture health and wellbeing data. However, most of these devices are not connected to each other and each has their own separate web portal. We will describe our Health Mashups system and how the data mined from multiple wellbeing sensors and contextual information has helped our participants learn deeper insights about their wellbeing and inspire positive changes in their lives which are not visible in traditional time-series plots.

Author Keywords

Health, Mashups, Context, Behavior Change, Weight, Activity Tracking.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Human Factors

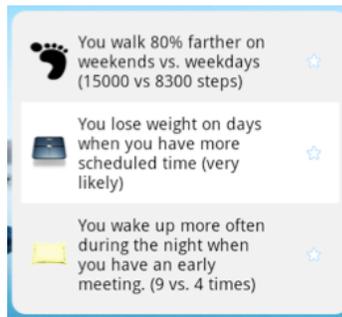


figure 1: The mobile widget for the feed of observations from the Health Mashups system.

Automatic Upload

- Weight (Withings scale)
- Body Fat (Withings scale)
- Step Count (Fitbit)
- Hours Slept (Fitbit)
- Times Awoken (Fitbit)
- Location (phone)
- Hours Busy (in calendar)

Manual Data Entry

- Food
- Exercise

table 1: Data collected in phase 1 of the Health Mashups system

Introduction

In the past few years, a large number of relatively inexpensive consumer health devices have emerged. These devices generally measure one particular aspect of a person's health or wellbeing (weight, step count, workout data, etc.) and store this data in a siloed web portal. Rarely do these web portals talk to each other. When they do, they mainly import data to be presented in time-series plots without being further analyzed.

For example, the Fitbit site allows for importing weight data from a Withings scale. Step count data from the fitbit can be viewed in one graph and weight can be viewed on another. There is no way for users to understand the relationship between these two aspects of their health.

Beyond the individual sensors, there are many aspects of a person's environment that can affect their wellbeing as shown by Li et al [5]. Weather, location, events from a calendar, and other contextual factors can all influence a person's decision to work out or to choose particular foods to eat. However, beyond basic labeling, there are currently no easy ways to visualize all of this contextual information with wellbeing data and especially to understand potentially complex correlations that occur over longer time periods.

We are tackling the opportunity provided by the large amounts of personal wellbeing data available on new consumer devices as well as the large amount of context that we can capture from mobile phones. We have seen that by allowing users to see how these aspects of their life are related, they will be able to make better decisions about their own wellbeing.

Related Work

Li et al [4-5] have explored how context and wellbeing can be co-visualized and how context can help users make sense of activity logs by displaying labels of contextual information alongside their wellbeing data. This is definitely a necessary first step, however we are also interested in helping users identify patterns that occur over longer periods of time and how context and their wellbeing interact over disjoint periods of time (e.g. differences between weekends and weekdays, overall correlations between activity levels and meetings on their calendar, etc.)

Consolvo et al [1-2] have studied behavior change that can be inspired from visualizations of wellbeing data. In the Ubifit Garden, participants were reminded about their activity levels through an active wallpaper on their mobile phones. This encouraged increased physical activity over a control group that did not have the visualization. We would like to explore this further and see if multiple sources of information could also be presented in a simple coherent way to create an increased awareness of various forms of activities.

Fogg et al [3] have also worked on creating systems that encourage positive health-related behavior change and discuss several systems that give reminders and feedback to users while mobile. While a great start to showing the power of the mobile device to influence change, most of these systems provided simple text - based reminders and did not seek to mine large repositories of personal data and context.

Health Mashups

Our Health Mashups platform centers on a server that interfaces with multiple wellbeing and contextual

sensors. This server can access data through web service APIs or directly from devices themselves. In a first version of the system, we received daily step count and sleep data from a Fitbit, weight and bodyfat from a Withings scale, and city-level location and calendar free/busy data from a mobile phone (see table 1). Additionally, we provided a mobile phone widget for manually logging food and exercise. We are now working on adding additional automatically-collected attributes such as weather, pollen levels, etc.

The Mashups system performs a statistical analysis of all uploaded data for each user on a nightly basis and identifies correlations between inputs as well as significant deviations that occur during particular time periods (e.g. weekends vs. weekdays). This system then produces a feed of relevant wellbeing observations that users can view on a widget on their mobile phone or on a website.

This feed can contain items such as “Your sleep is more interrupted on nights before you have very busy days,” or “On Tuesdays you walk significantly less than other days.” These insights are typically difficult for people to make on their own, given the difficulty in visualizing data from multiple sources over longer time periods.

Study

In the summer of 2011, we conducted an initial field study of the system. We were interested in the ways in which people would use the mashups data as well as the ability of our algorithms to work on real-world data and produce feed items that are useful.

We recruited ten diverse participants in Chicago and Stockholm to participate in the study for two months.

In the first month, participants had access to all of the health sensors and their individual websites. In the second half of the study, we added the feed of observations from our mashups system.

In the first half of the study, participants were asked to call into a voicemail system anytime that they had an insight about their wellbeing. All of these insights centered on a particular sensor and usually a single simple direction or data point (e.g. “I’ve been gaining weight.” “It’s hard to hit 10,000 steps!”)

However in the second half of the study, the insights were focused on an understanding of the items that came from the mashups server and how sleep, physical activity, weight, calendar appointments, and location combined in their lives and shaped their wellbeing together. Participant C1 commented on one of the feed items that told her that she tends to gain weight on Mondays: “It’s absolutely true! Cause on the weekends, like last Sunday, I went to my mom’s house and she made blackberry cobbler and I ate some of it.” C3 saw another correlation that made sense to her: “It says I eat less on days when I walk more, which I think is interesting. I think it means that just when I’m more active I tend to eat less and I think it’s probably accurate because when I eat more it’s probably because I’m bored or snacking.”

These two examples of new insights show how our users started to reflect on their wellbeing in ways that they had not previously thought. Understanding the connections between these aspects of their lives will hopefully lead to added reflection and longer-term behavior changes.

Discussion

Health data does not exist in a vacuum. Weight, daily step counts, and other aspects of one's wellbeing are all connected, not only to each other but to aspects of context in daily life. Presenting separate time-series graphs of independent sensors, as is common in most online wellness tools today, will not help people to fully understand these complex relationships and make their way toward understanding behaviors that should be changed.

By analyzing hundreds of possible correlations or deviations in wellbeing data across a wide variety of other data and context, we can surface these hidden trends for people and help them to better understand their own wellbeing. Do busy days in your calendar cause you to gain or lose weight? Do you lose weight on days when you exercise (or does your post-workout feast cancel out any effect)? Do you sleep better or worse on nights after a workout?

The answers to all of these questions are individually different and previously have only been answered by

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References

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those with a good deal of time and Excel skills. The quantitative self community continues to explore these issues, but largely in an individual way. Systems that can create these types of analyses for everyday non-geeks can help to make everyone more aware of how their bodies work and how best to improve their wellbeing.

The study also revealed that daily use of wellbeing and contextual sensors needs a strong continuing relationship with the user. Having appropriate reminders and encouragement are necessary to ensure that enough data is collected and the system can have enough information to operate..

This explosion of personal wellbeing data needs a similar explosion in analytics to what is occurring in the banking or media industries. We hope that systems such as Health Mashups are the first in a line of services that allow people to find these hidden long-term patterns in their lives and improve their overall wellbeing.

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